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論文の内容の要旨

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This dissertation has proposed a scheduling method on project management by using Max-Plus Linear (MPL) system. To provide a succinct framework which can handle a large-scale project system and can take into account the uncertainties of task durations, we apply the concept of Critical Chain Project Management (CCPM) based on the Max-Plus Linear Representation. The dissertation consists of 6 Chapters.

Chapter 1 describes the general statement, the purpose and organization of this dissertation. CCPM is a well-known method for planning and managing projects. The CCPM method focuses on monitoring a critical chain which is the longest chain of successive tasks in a project taking into account the dependence of task logic and the resource constraint. Based on the identification of the critical chain, the CCPM designs the position and size for the insertion of time buffers. Moreover, the CCPM can well deal with a complex system of multiple interdependent projects. On the other hand, Max-plus algebra is an easy-to-use tool for describing a certain class of discrete event systems (DESs), such as manufacturing systems, transportation systems, and project management. MPL system is a class of linear equations in max-plus algebra, which is known as an effective device of scheduling for DESs. Recently, an application of the CCPM method to the MPL representation was developed. The concept of time buffers in the CCPM method was described in the form of MPL representation, to readily analyze the system. Though the framework works well, it made two technical assumptions that the system consists of a single project and that the input times are equal to zero. For the management of a practical system, this research will develop an improved method for determining and managing time buffers in a single-project system as well as an extended method for multi-project system.

Chapter 2 gives the preliminaries of CCPM concept and MPL System, which are the essential background for this research. The first part will briefly review the basic concept of CCPM, focusing on determining and managing time buffers in single-project and multi-project systems. The second part will present Max-Plus algebra, MPL System, and Max-Plus Representation. These are the fundamental mathematical techniques used throughout this study.

Chapter 3 improves the aforementioned framework for determining time buffers in a single project, to handle a system with various input times using the MPL representation of input/task constraints. Since the input times here are subject to the uncertainties in the starting time of resources and materials, which in turn induces a drastic change on the position and size of these buffers. In this chapter, the potential unsolved problems of the previous framework are analyzed, and then the improved framework to solve these unsolved problems is proposed. For a single-project, a project buffer is inserted at the end of the critical chain and feeding buffers are inserted wherever a non-critical chain merges the critical chain. These concepts are defined in the term of MPL which is stable under changes in the input times.

Chapter 4 extends the framework of a single-project system to a multi-project system with mutual dependence. Different to the case of a single project which tries to minimize the duration of each project, the multi-project scheduling aims to maximize the throughput of the entire system by sharing the same resources. Thus, the insertion of the buffers is considered in both the constraint of interdependent tasks and the constraint of the shared resources among projects. By introducing a matrix which represents the layers of the projects, we determine project and feeding buffers for each project in only one system instead of considering them independently. In addition, we identify the key-resources, the designed resources who work across all projects. Then, we add capacity buffers at the transitions of the key-resources between the projects, to ensure that the key-resources are available for the subsequent project. The insertion of these buffers is defined in MPL form to reduce the complexity of management in a large-scale system.

Chapter 5 presents a CCPM-MPL framework for managing time buffers which are determined in Chapters 3 and 4. As well as the determination of the time buffers, a frequent monitor of the consumption of the time buffers significantly contributes to the success of the CCPM. By introducing a vector for inspection, which represents the actual completion time of the completed processes at the monitoring stage, the managers can frequently surveying the rates of the consumed buffers and the elapsed time. Their relation expresses the performance of the projects through a chart and detects a potential problem during the execution. Moreover, the entire procedure of the buffer management is simply described using MPL representation, which enables managers to make an effective decision on project scheduling.

Finally, Chapter 6 gives conclusions and future perspective of this research.